

DIAGONAL

FOCUS

Forest Reserves: Where nature has priority

No. 1
17

Masting:

Why do trees produce masses of fruit?

p. 20

Romania:

Wilderness ok, but no restrictions please, p. 22

Jungfrau railway:

Better protected against ice fall thanks to expert assessments, p. 29

EDITORIAL

Dear reader

Since the fall of the Iron Curtain, WSL researchers have been regularly travelling to Ukraine and Bulgaria. There they find something that no longer exists in Switzerland: almost undisturbed forests, which, like our forests, consist mostly of beech and spruce. These geographical journeys are also like journeys in time and have revealed how forests used to look before humans used them. Is it a form of colonialization for our researchers to study the virgin forests in these economically weak countries? I don't think so. The work is cooperative, and several young Ukrainian researchers have, thanks to the partnerships with WSL, been able to pursue their studies in Switzerland. Knowledge is recognized to be a good that increases if it is shared. And it knows no borders, which means research cannot be restricted to one country. This is why we are glad that Switzerland has found a reasonable way to implement the Popular Initiative "Stop Mass Immigration" so that we can again be involved in European research through Horizon2020.

I wish you an enjoyable read.



Prof. Dr. Konrad Steffen
Director WSL



Forest Reserves



ONE-TWO

Ulrich Mergner, Bavarian State Forestry Department: "I don't think it makes much sense to stop using an ordinary forest just to make up the percentage."

→ **10**



COLLABORATING ON RESEARCH IN VIRGIN FORESTS IS USEFUL FOR BOTH PARTNERS

Thanks to the research on virgin forests in Ukraine and Bulgaria, we now understand better how Swiss forests develop.

→ **13**



IT DEPENDS ON THE QUALITY

Despite more deadwood in Swiss forests, half of all wood-dwelling beetle species are threatened.

→ **16**



RETURN TO THE WILD?

What happens to a forest if it is no longer managed? Research in natural forest reserves provides some answers.

→ **2**

KEY TOPICS

20 FOREST

22 LANDSCAPE

24 BIODIVERSITY

28 NATURAL HAZARDS

32 SNOW AND ICE

PORTRAITS

19 Ani Bürgin, Trainee caretaker

27 Nora Helbig, Meteorologist


34 Matthias Bürgi, Environmental scientist

35 IMPRINT, OUTLOOK

36 THE OBJECT: SnowMicroPen

REPORTAGE What happens to a forest if it is no longer managed? Research in natural forest reserves provides some answers.

Return to the wild?

A photograph of two researchers in a forest. The researcher in the foreground is wearing a yellow long-sleeved shirt and a large orange and black backpack. The researcher in the background is wearing a blue cap, a red and black plaid shirt, and a green vest. They are standing in a field of tall grass, with a white and orange ranging pole and a compass visible. The forest background consists of many thin, grey tree trunks and some green foliage.

The trees' positions can be accurately measured with the help of a compass and ranging pole.



WSL staff follow a given protocol to carry out inventories in 49 Swiss natural forest reserves every 8 to 15 years.

Large quantities of deadwood, both standing and lying, are typical features of natural forest reserves.

Natural Forest Reserve Seeliwald (OW).

Photo: Gilbert Projer, WSL

When the WSL car stops, the woman walking along the tarred road that leads through Schlierental asks sceptically “Have you got a permit?” “Yes, of course,” answers Lucien Schoch, the young zivi, as men doing their civilian service are called, getting out of the car. He is splashed with paint. The passer-by walks on. She cannot have been in this idyllic valley high above Sarnen (OW) for quite a while because the WSL car has been parked here each morning for the past three weeks.

At the end of a short path across a field, Lucien plunges into the “Seeliwald” – a natural forest reserve in one of the now rare raised bogs in Switzerland. In many places the ground consists of sphagnum moss, which is very soggy. Water squelches up from under the soles of your shoes with each step you take. The blueberry bushes between the upright mountain pines are knee-high and full of dangling berries. The pine trees with their grey trunks are mostly short and dotted across the mossy ground, sometimes loosely and sometimes in dense groups. A striking number of the trees are dead, but their roots keep them standing upright. It is not just the type of vegetation here that makes it feel like Scandinavia, but also the silence – apart from some birds calling – with the hectic of the city far away.

Natural dynamics instead of timber yields

For about 60 years, ETH Zurich has been monitoring how the forest develops in natural forest reserves like Seeliwald. These forests were once managed, but are now left alone to develop naturally under contractual guarantee. This protection en-

sure that the forest can go through its entire development process without being disturbed, and the trees can germinate, grow, age, die and decompose with no human interference. Such forests also provide habitats for many animal and plant species that have become rare in managed forests. Since 2007, ETH and WSL have managed the project jointly, with considerable support from the Federal Office for the Environment (FOEN), and now monitor 49 reserves. In comparison with the rest of Europe, Switzerland has a diverse network of relatively old natural forest reserves. Seeliwald, which is at about 1450 m a.s.l., is one of the larger reserves covering 80 ha. It has been protected since 1972, when ETH signed a contract with the owner of the forest, the Corporation Schwendi.

Seeliwald, like many of the other early reserves, grows on an unproductive site. Only the mountain pines can cope with the bog's acidic, nutrient-poor and wet soil, and even they grow only very slowly. Moreover, peat bogs are difficult to drive on. The forest's low yield potential and restricted accessibility may have helped to persuade the owners to let the forest be protected – especially as they received financial compensation in return for not using it. Finding large areas of productive forest to set aside as reserves was, and still is, much more difficult. This is one reason why the proportional area of forest reserves on the Central Plateau is the smallest in the whole of Switzerland (see the Infographic on p. 5).

Monitoring trees over time

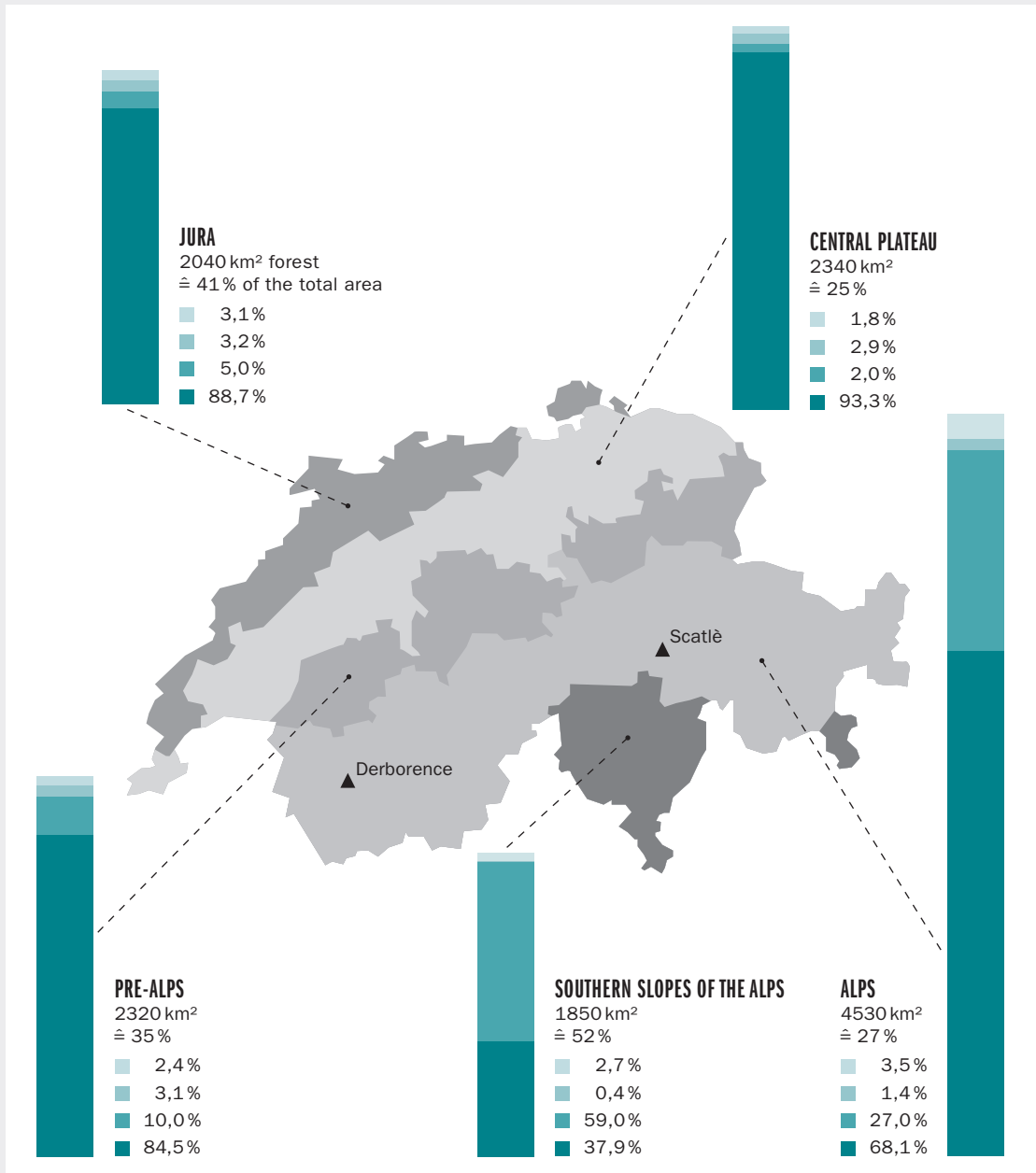
“There you are at last,” exclaims Jonas Stillhard when Lucien appears, and adds with a wink: “Did you get lost?” The 33-year-old environmental engineer and his team, consisting of another zivi, David FitzGerald, and the two field technicians, Gilbert Projer and Gallus Keller, had got to the Seeliwald earlier in the morning than Lucien. While Jonas cleans the trees with a wire brush, David picks up the stamping set: ‘73’, ‘85’, ‘95’ – all trees get a number in color as soon as they reach a diameter of at least 4 cm. The trees marked in blue grow in one of the six permanent plots roughly 1 ha in size. Each time an inventory of the permanent plots is made – this one is the fourth since the Reserve was established – the fate of the marked trees is exactly recorded. Jonas: “We measure the diameter, note the species and record any structural details like holes or cracks that can serve as important habitats for animals, fungi and plants.”

Jonas hands the wire brush to Lucien and leaves the two zivis alone to mark the trees. They move on to the sample plots, one of the innovations introduced in 2007. In the Seeliwald, altogether 99 of these 500 m² circular plots are distributed in a fixed grid across the whole Reserve. Gilbert and Gallus have just started to tackle sample plot 56. They are holding a Transponder and Vertex – tools that are also used in land surveying to measure the distance between two points. Gallus tells Gilbert which tree to look at, and measures the diameter at breast height with so-called calipers. Gallus uses the Vertex to measure the height of the tree, assesses whether it is dead or alive, and checks the condition of its crown, recording all the data directly in the field computer. Following a set protocol, they register any young trees growing on a sub-plot and how much deadwood is lying around. If one of them is unsure about the

For more information on the research in Swiss forest reserves, see: www.wsl.ch/more/forestreserves

INFOGRAPHIC Forest reserves, unmanaged forests and commercial forests in Switzerland

Around five per cent of the forests in Switzerland have so far received protection as reserves. Many more forests, however, especially in the Alps and on their southern slopes, have not been used for decades because managing them is not profitable. They are mostly developing naturally, but their protection is not guaranteed in the long term.



- ▲ Virgin forests: Forests with no traces of earlier timber use make up less than 0.01% of the Swiss forest area.
- Natural forest reserves: These protected areas can develop naturally because they are no longer managed in any way.
- Special forest reserves: Targeted silvicultural interventions should promote particular animal or plant species, or involve traditional forms of use.
- Unmanaged forests: Most of these forests areas have not been used for more than 50 years, and their development today is largely natural.
- Commercial forests: Using the timber is the main priority in these forests, although the kind and intensity of management interventions will determine how close to nature the forests can develop.



Jonas Stillhard uses calipers to measure the diameter of a mountain pine.

assessment, the other will help out. They are clearly an experienced team after working together almost every day for months. Jonas also helps with the field surveys from time to time, as he has done for the past few days in Seeliwald. More often, however, he can be found in his office coordinating his colleagues' fieldwork or focusing on the database in which all the Reserve project's survey data is stored. At the moment he is working on transferring all of the data gathered since 1948 into a new database and correcting inconsistencies. Jonas:


“Over the years so many different people have worked on the same project that some errors are inevitable.”

A new virgin forest is forming

Many research projects have come about thanks to data from the Reserve Project. According to one such study, the reserves are already beginning to show some of the characteristics of a virgin forest with, for example, more deadwood and large diameter trees than in a managed forest. If this development is to continue, however, it will be essential to protect the Reserve for much longer than the normal contract period of 50 years. And even then, it will still be different from a real virgin forest such as that which once covered the landscape before any of the wood and timber was used. Instead, it will turn into a new form of virgin forest: a so-called natural forest. Conditions today are different: the climate is warmer, large carnivores no longer roam the forests and regulate the growing populations of wild ungulates, and more nitrogen is entering the forest floor via the air.


Last year a Masters student assessed, for the first time, how much deadwood she found lying in the spruce-dominated mountain forest reserves. Such indicator values provide valuable references for making recommendations about how much deadwood is necessary in forests, including managed ones, to promote those species that depend on it. A doctoral thesis was also published last year, which used the enormous data-set to model the mortality of different tree species. These findings are also relevant for the owners of managed forests. Jonas: “Knowing, for example, that a valuable admixed tree species can thrive in natural forest reserves in large enough numbers and good enough quality without any expensive interventions could mean less pressure on forest owners’ wallets, especially with the low prices for timber today.”

After a long day in the field, Gilbert, Gallus and Jonas pack up their things. They have assessed six sample plots today. The two zivis are already waiting by the car. During the around three months it takes to do the inventory in Seeliwald, the men will examine up to 7000 trees closely. This is work which even today no modern technology can do for them. The inventory will not be repeated again for another 10 to 20 years. *(chu)*

A photograph of a forest with a grassy slope. The foreground is filled with tall green grass and ferns. The middle ground shows a dense forest of tall, thin trees with green foliage. The background is a thick canopy of trees. Two white text boxes are overlaid on the image.

In special forest reserves, endangered species are promoted through active interventions. These species include, in particular, those that need open forests, such as the capercaillie.

In Amden, WSL is studying, together with the Swiss Ornithological Institute in Sempach and the forestry service, whether the promotion measures in the Special Forest Reserve have had a positive effect on the habitat quality and the capercaillie population.



The capercaillie needs space and doesn't like it if the trees are too close together. Forest aisles make it easier for it to move between stands and reach roosting and dormitory trees.

A thinned forest stand lets in lots of light through to the ground. This benefits blueberries, which supplement the diet of the capercaillie in summer.

Habitat improvement measures in the Special Forest Reserve Amden (SG).

ONE-TWO High species diversity through protection and use. Forest reserves provide habitats for threatened animal and plant species. But species diversity can still be high in commercial forests. A conversation with Kurt Bollmann, WSL, and Ulrich Mergner, Bavarian State Forestry Enterprise.

In forest reserves the forest is contractually protected. The aim is for such reserves to make up 10 per cent of the forest area in Switzerland by 2030. What do you think about this as a goal?

UM: From the point of view of species diversity, it makes no difference whether five, eight or ten per cent is protected. Much more important is whether habitat structures like tree hollows, cracked bark or dead branches are present to provide habitats for many different species. I don't think it makes much sense to stop using an ordinary forest just to make up the percentage. In our forest enterprise, Steigerwald, we have set aside areas where there are clusters of trees with habitat structures. With its forest reserves, 200 'stepping-stone' areas, and 10 habitat trees per hectare, altogether 12 per cent of the forest area is left unused.

KB: The percentage is a political decision and is not based on scientific findings. Initially there was too much discussion about numbers and too little about content. To maintain species diversity, not only are habitat structures and diverse management types necessary, but so too are natural processes like storms, forest fires or floods. These create new habitats and can wake up certain 'sleeping beauty' species.

The sage-leaved rock rose in Ticino, for example, may suddenly reappear after a fire. In a managed landscape, mandatorily protected areas are therefore necessary to allow natural processes to shape the habitats. If the living conditions there are optimal, strong populations may develop in the protected areas and then spread from there to other areas.

How natural are natural forest reserves really?

UM: In this part of Bavaria, every square meter of forest, regardless of whether it is managed forest or a natural forest reserve, will have been clear cut at some point during past centuries. You cannot find any virgin forest here or almost anywhere in Germany. But natural forest reserves may harbour up to 60 to 70 per cent of the species inventory found in a virgin forest, and thus serve as a kind of life insurance. They, or at least their structures and processes, can develop to become more like the virgin forests I have seen in Romania and Iran.

Is species richness greater in untouched forests than in managed forests?

KB: To create a coppice-with-standards forest, for example, the



Ulrich Mergner is head of the Bavarian State Forestry Department's "Steigerwald" forest enterprise near Würzburg, Germany



Kurt Bollmann is head of the Research Group "Conservation Biology" at WSL.

forest must be used very intensively. Of the older trees, however, only oaks are occasionally used, whereas the young growth is cut down every 10 to 20 years. Nature conservationists like this kind of forest management because it provides temporary habitats for species requiring light and warmth. This example shows that, under certain conditions, intensive use can lead to a high level of species richness.

When should management interventions be made in a natural forest reserve?

UM: We do not intervene in our natural forest reserves. Sometimes storms create gaps, which are then mostly filled by beech. These are overwhelmingly dominant in comparison with oaks, which means we will probably lose the oak. The resulting discussion is confusing for conservationists. Hardliners say “Nature is nature! Then the oak will just have to go.” Others say “But you can’t let the oak disappear.” This last group wants to intervene in natural forest reserves. But we don’t do that. We can protect the oak in commercial forests and keep single oak trees. Maybe something will happen sometime, perhaps due to climate warming, which will change everything.

KB: We used to have a much clearer idea about which species occurred naturally in particular locations and in which proportions. Recent forest and climate research has shown us that we must adapt to changes. The example of the oak and the dominant beech indicates that natural forest reserves are not the broadband solution for all

nature conservation issues. We need special forest reserves and an ecologically oriented forest management.

Why is it that most research takes place in reserves?

KB: In ecological research the natural environment was studied for long periods in places where people are not constantly interfering, i.e. in national parks and reserves. This has reinforced the notion that only in such areas can ‘real nature’ be found. Used landscapes have not been considered as much, which has made forest ecology research a bit biased. This is where I see a need for action.

UM: For us research in natural forest reserves has been and still is very important. Knowing, for example, which species occur in reserves means we can make comparisons with commercial forests. We would like to see all these species growing in commercial forests – not in the same density, but in the same numbers. I completely agree with Kurt Bollmann that too little research has been done in commercial forests, but research in reserves is also useful as we still need to be able to make comparisons.

In special forest reserves, interventions are made to promote particular species. How do you decide which species, e.g. the capercaillie, to concentrate on?

UM: It is a question of taste. There is no rational reason why, say, the capercaillie should be promoted. The bird has always impressed hunters. It was considered a great skill to be able to stalk the cock.



Thinning dark forests benefits not only the capercaillie, but also other rare animal and plant species.

Today great efforts are made with all kinds of measures to help the capercaillie survive even though the habitat has changed. In some regions we participate in these programmes because they are required for nature conservation. Personally though I consider it rather nonsensical to concentrate on just one species in species conservation and tacitly accept that other species may then have to disappear.

KB: There is no scientific reason for favouring the capercaillie over a saproxylic beetle. This example demonstrates how nature conservation is influenced by human values, norms and priorities. These often have to do with a species' aura, kept alive through literature, hunting, songs and folk art. In Switzerland we are a little

less emotional about it than our neighbours. Before the national promotion program for the capercaillie started in 2008, facts were required. WSL was able to show that other rare species could, under the umbrella of the capercaillie, also benefit from the thinning of closed and dark mountain forest stands.

UM: I have some sympathy for the idea of an umbrella species representing a large number of other species. When considering the conservation of forest species, however, the focus should be on near-natural habitats with many habitat trees and large quantities of deadwood. *(lbo)*

“Intensive use can, under certain conditions, lead to high species richness.”

EAST-WEST COOPERATION **Collaborating on research in virgin forests is useful for both partners.** In Ukraine and Bulgaria, virgin forests still cover large areas. They are important objects of study for researchers at WSL for finding out more about developments in Swiss forest reserves and protection forests.

Nowhere in Europe are virgin beech forests larger than in the Ukrainian Carpathians. In Switzerland, in contrast, where the beech is the most frequent broadleaf species, all beech forests have been managed for hundreds of years. Even today's beech forest reserves were previously used for a long time. With the demand for large forest reserves on the Central Plateau, interest in virgin beech forests has also greatly increased. This is why, in April 1999, Brigitte Commarmot and Anton Bürgi from WSL visited the Carpathian Biosphere Reserve in West Ukraine for the first time. The two forest scientists wanted to find out whether it would be feasible to carry out a project to compare the natural development of these virgin forests with that in forest reserves and near-natural managed beech forests in Switzerland.

They were able to carry out the planned project and the original trip turned into more than twenty. Since then, Brigitte and other researchers from WSL and Ukraine have dug ever deeper into the secrets of Uholka-Shyrokyi Luh, a virgin forest around 100 km² in area, which consists almost entirely of beech. There they found trees up to 500 years old and roughly ten times as much standing and lying deadwood per hectare as, on average, in the forests on the Swiss Central Plateau and the Jura. One in three of the living trees had hollows,

For further information on the cooperation between WSL and Ukraine in research on virgin forests and natural forests, see: www.wsl.ch/more/virginforest-ukraine



The blue slug (*Bielzia coerulans*), which occurs in the Transcarpathian virgin forest, grows to be a good 10 centimeters long and is mostly monochrome blue to black. Young specimens may also shimmer in green, yellow and other colours.

cracks or other wounds, which provided microhabitats for insects, bats, birds and other animals, such as the blue slug, the most striking slug in these forests. In this virgin forest, researchers at WSL, together with their Ukrainian partners, caught three times as many rare species of beetle dependent on old and deadwood as in old beech forests in Switzerland. They also found rare lichens in high densities that benefited from the presence of old trees.

Virgin forests as a reference for forest reserves

How does this cooperation help Switzerland? “The virgin beech forest in Ukraine is a vast research lab for us,” says Brigitte Commarmot, who for many years coordinated the cooperation for WSL. “Forests largely uninfluenced by humans are an important reference. We use them to assess how close to nature Swiss forest reserves such as Sihlwald near Zürich are, and to find out how management affects biodiversity.” And how does this help Ukraine? Through the cooperation WSL’s partners have obtained access to the international research community. “During the 17 years of collaboration, we have got to know many very motivated and gifted young researchers in West Ukraine,” says Brigitte. Six of them managed to get federal scholarships for extensive periods of study at WSL and at Swiss universities. Several have completed or nearly finished their doctorates. It is moreover important for the Ukrainian researchers not only to receive expert support at WSL, but also to have access to labs with modern equipment, for example, for genetic investigations.

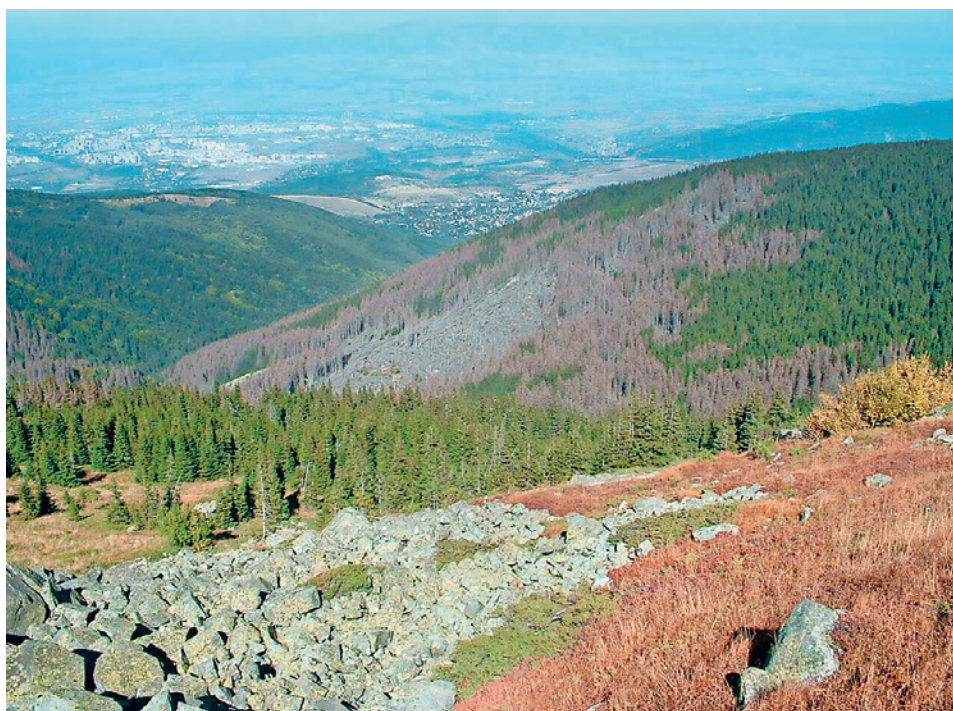
Internationally, the unique data-set, collected over many years, on the development of the largest virgin beech forest in Europe has met with great interest. It probably helped the Ukrainian and Slovakian virgin forests receive the label ‘UNESCO World Natural Heritage’ in 2007. “The label counteracts the pressure from domestic and foreign companies to use the forests and helps to protect them in the long term,” says Brigitte. She retired in May 2017. Peter Brang is continuing her work.

Wind, snow and light in Bulgarian protection forests

Peter Bebi, at SLF in Davos, is investigating how dense or light forests need to be to provide protection against avalanches, debris flows and rockfall. Until recently, he also had no reference to refer to in managing protection forests. Forests with such natural structures can be found in, for example, Bulgaria, where there are still large forest reserves with virgin forests in mountainous regions, as well as conifer forests that have not been managed for a long time. They are similar to typical protection forests in the Alps. The trees often grow very close together and are thus particularly vulnerable to storms and snowbreak. Peter therefore considered it very opportune when he was contacted by Momchil Panayotov from the Forestry University in Sofia. Momchil was interested in studying such forests in Switzerland during a postdoc visit and comparing them with similar forests in his home country.

Ten years later, the two of them have completed several projects in Bulgarian mountain forests and published their results. These have helped Peter estimate the effects of windthrow, bark beetle infestations and other natural events on how well the forests provide protection against natural hazards. The focus is on the influence of overly dense tree stands on the stability of the forest and

For further information on avalanche protection forests, see (text in German or French): www.wsl.ch/more/bulgarien



In the biosphere reserve 'Bistrishko branishte' (West Bulgaria), the mainly spruce mountain forests are very similar to some protection forests in Switzerland. In 2001 60 hectares were subjected to windthrow, and later to bark beetles and forest fires.

the natural regeneration of young trees. Peter hopes that the findings from the Bulgarian virgin forests will help to improve recommendations for managing protection forests. Momchil values the cooperation especially as he can then exchange experiences and his team can today be part of an international network of mountain forest researchers.

Achieving a great deal with limited means

The cooperation between scientists from East and West meant, for both sides, first taking an uncertain step into a new research culture. Today, however, all participants consider the cooperation to be extremely valuable. The reference areas in Bulgaria, which have developed naturally, have helped the researchers understand and describe the long-term development of these forests better. "We need to know what extremes states of a forest we should take into account to ensure the best possible protection against natural hazards," says Peter Bebi with Brigitte Commarmot's full agreement. "What's more," she adds, "we have learnt from our East European partners what an incredible amount we can achieve in often difficult circumstances with limited means." *(rlä)*

DEADWOOD It depends on the quality. Although the quantity of deadwood in Swiss forests is continuing to increase, half of all wood-dwelling beetle species are threatened. There is not enough deadwood of appropriate quality.

Is deadwood, i.e. dead trees and parts of trees, really dead? Deadwood provides one of the most species-rich and important habitats in the forest. Roughly a quarter of all species living in the forest require deadwood. In Switzerland alone this means 2700 fungi, 150 lichen and 1700 beetle species, along with larger animals such as woodpeckers, dormice, bats and some reptiles. Furthermore, every second young spruce in mountain forests grows on decaying tree logs.

Almost half of the deadwood-dwelling beetle species are endangered. They are on the Federal Office of the Environment's (FOEN) Red List, which includes four of the large saproxylic families. "This shows that we have a problem," says a co-author of the Red List, Thibault Lachat, who is a visiting scientist at WSL and a professor at the School of Agricultural, Forest and Food Sciences HAFL. FOEN sees the lack of deadwood as "one of the greatest ecological deficits in the Swiss forest." The amount of deadwood in Swiss forests has, however, up to now increased continuously since the changeover to oil as a fuel – as the Swiss National Forest Inventory (NFI) performed by WSL has verified. The storms Vivian (1990) and Lothar (1999) greatly boosted the supply, as has the fact that harvesting timber in many regions is no longer profitable. According to the NFI, almost a fifth of Swiss forest stands have not been used for over 50 years (see the Infographic on p. 5). Moreover, many forest owners and managers today know that deadwood is ecologically valuable, and protect



In competition with humans: the endangered timberman beetle (*Acanthocinus aedilis*) requires dead, but still fresh, pine in warm, low-lying areas, i.e. in first-class building zones, of all places.

Photo: Beat Wermelinger, WSL

so-called habitat trees, i.e. old living trees with hollows and dead branches, and leave the remnants of timber harvesting lying in the forest.

On average, 24 m³ of deadwood can be found in one hectare of Swiss forest today, which is enough to fill roughly 200 bathtubs. This is already quite close to the target values specified in the federal government's Forest Policy 2020 to promote species diversity: mountain forests should contain 25 cubic meters per hectare and forests on the Central Plateau 20 m³/ha. But these values are still far away from those in natural, not to mention, virgin forests. Natural forest reserves contain between 50 to 130 m³/ha deadwood after several years without use, whereas virgin forests have, on average, as much as 140 m³/ha. "It is a good starting point to have target values," says Beat Wermelinger, insect specialist at WSL, although he thinks they reflect more what is politically feasible than what is necessary. "These measures meet the needs of many species over large areas, although not of highly specialized species." In his new book "Insects in Forests" (in German), he devotes a chapter each to deadwood and endangered forest insects.

Alluvial and open forests are disappearing

Why is it then that so many deadwood species are still on the Red List? What is lacking is mainly deadwood of special quality. According to Thibault Lachat, habitat trees have become very rare, as have thick dead tree stems standing or lying in the sun, as well as wood in advanced stages of decay. In commercial forests, trees are felled well before they become 'senile'. A silver fir can live to be 500 to 600 years old, but is normally harvested when it is 90 to 130 years old.

Old trees, sunlit alluvial and broadleaf forests in the lowlands, stepped forest edges, chestnut orchards and old standard fruit trees are today rare. These are, however, just the habitats that the 118 indigenous saproxylic beetle species

For further information on deadwood, see (text in German or French): www.totholz.ch



In Swiss forests there are on average 24 cubic meters of deadwood per hectare – which is more than it was 50 years ago, but still far removed from the amount found in natural and virgin forests.

that have landed on the Red List require. To draw up this List, species specialists have captured 256 species of jewel, longhorn and stag beetles, as well as rose chafers, by hand with sweep nets, beating sheets or traps at a total of 240 sites in Switzerland where these rare species were expected to occur. Almost half of the species from these four large families (46 %) are considered ‘vulnerable’ on the Red List, according to the criteria of the International Union for the Conservation of Nature IUCN, and a further 47 species (18 %) as ‘near threatened’.

The most important recommendation of the Red List is, then, to promote the habitats of these specialized species. A WSL fact sheet for practitioners (Merkblatt für die Praxis) “Deadwood in forests” («Totholz im Wald» – in German only) shows in detail how this can be done. It draws on the results of the WSL project “Dynamics of dead wood and saproxylic insects in forest reserves”, which ran from 2009 to 2014. For example, the larvae of the endangered timberman beetle (*Acanthocinus aedilis*) can only develop under the bark of dead, but still fresh pines in warm, low-lying areas. The three-toed woodpecker, in contrast, only takes up residence in places where at least 18 m³ of dry standing conifers per hectare are present. The federal government has recently begun to provide financial support to promote old wood and deadwood. Those who create so-called old growth patches in commercial forest, i.e. sites where especially large diameter or old deadwood can be left, and who leave habitat trees standing until they fully decay receive money. These ‘stepping-stones’ should help to bridge the large distances between the individual forest reserves and give less mobile species a chance to spread. The WSL fact sheet for practitioners describes how this is ecologically beneficial and how it can be implemented without risk for workers and visitors in the forest.

All these efforts to support deadwood species have recently met with a strong counterforce: the boom in energy wood. Biomass is considered to be an important source of renewable energy. “Since it also uses low quality wood, the current increase in deadwood may slow down or reverse,” Beat fears. In a new study, Thibault has shown that deadwood insects like to colonize piles of energy wood left lying during the summer until they are processed. WSL is studying whether this presents a problem for the survival of beetles in forest and is compiling tips for storing energy wood. (bki)

For information on forest insect research at WSL, see: www.wsl.ch/more/forestinsects



Ani Bürgin, Birmensdorf

“I grew up in this courtyard in Zurich’s District 3. We kids were a real gang and liked playing football outside all the time. When I go out for a walk in the area, I often visit this oasis.”

IN THE INTERESTS OF THE STAFF

Changing light bulbs and mending leaky taps, mowing the lawn in summer and making sure that no one slips on the icy paths in winter – these are the kinds of tasks that keep Ani Bürgin continually on the go in WSL’s extensive premises in

Birmensdorf. As a trainee caretaker, she likes the variety her job offers: “I enjoy providing services for WSL staff. Working with all different kinds of people is great fun.”

FORESTS Why do forest trees sometimes produce such masses of fruit? Volunteers help with the research



If almost all the trees in a region produce masses of fruit like this beech, we talk about 'mast seeding'.

Last autumn the beech trees on Switzerland's Central Plateau were filled with immense quantities of tiny beech-nuts. Regular forest visitors know that this does not happen every year. Thomas Wohlgemuth, a biologist at WSL, says: "This phenomenon occurs with beech about once every three years, and with spruce every six years. We call it mast seeding or masting. So far we know little about why this happens, what roles climate and weather play or what it means for other plants and animals in the forest." It could be evolutionarily advantageous for the trees to produce massive quantities of seed once every few years instead of each year, perhaps because pollination then works better or more seedlings survive. For researchers to under-

stand forest regeneration, they need to study the mast phenomenon as well because seed or fruit production is the first step in the process.

For this they need data. Records are available for some tree species from practical forestry. Anton Burkart, head of WSL's experimental garden, has, since 1991, kept annual records of where particular tree species bear fruit in Switzerland and how much they produce. These records provide the core dataset for Thomas Wohlgemuth. But he needs much more information. "Here we rely on Citizen Science. This means that anyone interested can help us," explains Tom. He and his colleagues have constructed the online portal www.mastweb.ch where experts and laypeople can enter how full of seeds or fruit

forest trees are. To begin with, the focus is on six tree species. But it is planned to expand this to about twenty species, including some of those typical for the Southern slopes of the Alps, such as the chestnut. Observations of years with no or almost no seed production over a large area are also valuable.

Tom thinks the growing dataset has a lot of potential. Even the records his colleague Anton Burkart provided have, on evaluation, already revealed interesting interconnections. He noticed, for example, that during a winter after an oak mast hunters in Canton Zurich killed significantly more boars. The rich food supply seems to increase the natural survival rate of the boars, even though only 5% of the trees in the canton are oaks. Such studies might seem, at first sight to be researchers just playing around. If, however, mast years become more frequent – or perhaps less frequent – due to changes in the climate, the ecosystem could markedly change with unknown consequences.

Fagus Sylvatica

- Absent fruiting
- Moderate fruiting
- Abundant fruiting



This map in www.mastweb.ch shows that beech mast seeding occurred in all parts of Switzerland in 2016 (coloured green).

And the volunteer reporters? They can follow via the Internet how the maps showing the mast intensity of different tree species are produced using the many reports sent in. *(bio)*

www.mastweb.ch (in German)

FORESTS HeProMo: Assessing the cost of harvesting wood

What does it cost to harvest and transport a cubic meter of energy wood? WSL's revised wood-harvesting productivity model (HeProMo) provides answers to important questions like these for forestry. When data on the trees, terrain, personnel and machines is fed into the calculation tool, which is jointly financed by WSL and the Federal Office for the Environment, the output is the timber volume harvested per hour and the cost. The new model includes more processes than the earlier ver-

sion of HeProMo, such as chopping energy wood, transporting the wood chips and harvesting whole trees on a slope using a mobile tower yarder with a processor. Users include not only foresters, but also the federal government and researchers who want, for example, to assess the potential for using wood in Switzerland. *(bki)*

www.wsl.ch/more/hepromo-en

LANDSCAPES New nature reserves in Romania: Wilderness ok, but no restrictions please

Untouched forests, deep gorges and torrential streams – all can be found in the south-western Carpathians in Romania in some of the last wilderness areas in Europe. Here natural



The south-western Carpathians in Romania are considered to be some of the last wilderness areas in Europe.

processes can take their course largely without human interference. Most of these areas are already in existing nature conservation areas. Currently plans are under consideration to place the whole wilderness under special protection, but this requires the acceptance and support of the local

population. What are their attitudes to the wilderness areas? And what do they think about the already existing nature conservation areas in the region? WSL carried out two surveys in five Romanian nature conservation areas as part of a WWF project. The first took place in 2014, and the second in 2016 after WWF Romania ran an information campaign with documentary films, local workshops and leaflets about the topic of wilderness areas and how to protect them.

Originally Nicole Bauer, head of the WSL study in Romania, planned to do a written survey by post, but she says, “We were soon advised against this as postal services in these regions, if they exist at all, are unreliable.” Moreover many older people do not have much practice reading and writing. WWF Romania therefore organized Romanian social scientists to visit the remote areas and carry out the interviews there.

Wild nature is appreciated

The interviewees can be divided into two groups: ‘modern nature-lovers’, who want nature to develop freely, and ‘traditional nature-users’, who often own land and depend on the natural environment for their incomes. Both groups viewed wilderness areas positively even before the WWF campaign. They associate them with feelings of pleasure, freedom or are just fascinated by them. Both groups would, however, allow grazing in wilderness areas. They are also in favor of wind turbines there and would like more infrastructure such as roads. These responses are similar to those from a survey WSL carried

out in Switzerland more than 10 years ago. Here too respondents had positive attitudes to wilderness areas, but wanted at the same time more infrastructure in the form of benches and garbage bins.

The two groups identified in the Romanian study differ, however, where existing nature conservation areas are concerned. The ‘modern nature-lovers’ assess them much more positively than the other groups, and see them having more potential for tourism and economic development in the region. The ‘traditional nature-users’, on the other hand, associate the protected areas more with restrictions on everyday life.

It is important to communicate openly

Attitudes before and after the WWF campaign could not be compared because it was not possible to interview the same people twice. Respondents in the second survey tend, however, to view wilderness areas more positively. They also see the protected areas having more advantages than the respondents two years previously. There are, nevertheless, differences between the five regions, with assessments of the effects of particular protected areas on daily life varying. Respondents in the five regions do not feel they have the same level of information about the park in question and the measures taken by the park administration. This indicates that the history of how a conservation area was set up and how information about it has been communicated locally have great influence on public acceptance.

The recommendations the researchers made in Romania on the basis of the interviews sound familiar to Swiss ears: When new conser-

vation areas are planned, the people affected should be involved from the beginning. It is crucial to provide the public with clear information about any potential restrictions arising



These overgrown former agricultural areas also count as wilderness in Romania.

from setting up the new conservation area. This still does not mean it will automatically be accepted, as the case of the planned second National Park in Switzerland, Park Adula, showed. For it to go ahead, at least 13 of the 17 municipalities affected should have been in favor, but only nine voted for it in the November 2016 referendum. Despite all the reassurances of those promoting the Park, concerns about restrictions had more weight. In a WSL survey in 2013, just under half of the respondents said they were in favor of the new National Park. *(lbo)*

BIODIVERSITY Using genetic methods to track the history of Swiss stone pine



Swiss stone pine above the Aletsch Glacier.

For centuries many more Swiss stone pines were felled than regrew, mainly because humans used the fragrant wood in so many different ways. The stone pine is, however, much more important for people living in the central Alps as it is an integral part of high-altitude protection forests. It provides a habitat for specialized wildlife and forms an attractive landscape for recreation.

While stone-pine forests used to be overexploited, naturally regenerated stone pines today are encouraged and sometimes even planted. But which region should the young plants come from? Is the local stock original or do the stone pines originate from trees of non-local provenance planted in earlier times? Here the pattern of genetic

relationships can yield valuable information.

Felix Gugerli, Head of the Group ‘Ecological Genetics’, has, together with his team, analyzed about 3000 trees from nearly 140 stone-pine stands. The pines’ genetic fingerprints indicate that the populations in eastern Switzerland are distinct from those in western Switzerland, i.e. they are not closely related. Felix suspects that the ancestors of these two groups of populations outlasted the last Ice Age in two separate refugia along the southern fringe of the Alps. Pollen finds and the remains of subfossil wood, seeds and pinecones support this hypothesis. Why, though, can the eastern and western Swiss populations today still be genetically distinguished? Felix thinks:

“After the last Ice Age, the genetically distinct Swiss stone pines migrated back into the Alps from their respective refugia. While they do seem to have been in contact with each other in the region of the Gotthard Massif, they did not intermix much because the habitat was too inhospitable for the stone pine. The mountain range thus seems to have acted as a kind of barrier to genetic exchange.” Such contact zones can be found in other places throughout the Alps, which suggests there were other such Ice-Age refugia as well.

The findings of this study are of practical relevance as they indicate that local seed should be used for planting because it is presumably adapted to the environment in which it occurs. Ongoing research should show to what extent this will also apply under future environmental conditions. (rlä)

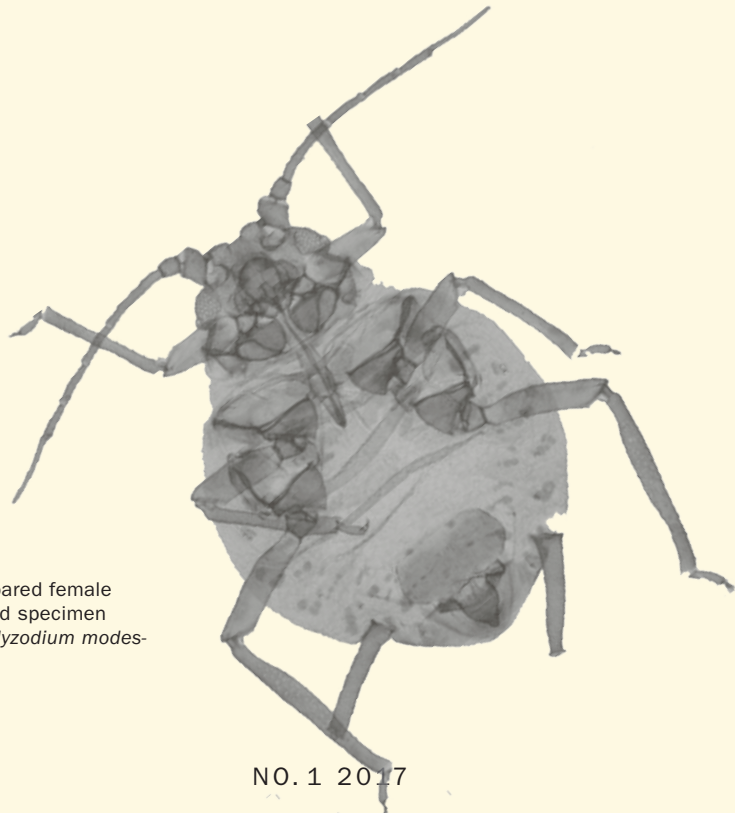
www.wsl.ch/more/stone_pine

BIODIVERSITY What’s going on in the moss? Aphids in the Swiss National Park

At the thought of aphids, people often just want to control them. In addition to the pests on crop and ornamental plants or the producers of forest honey, there are many other species of aphid, but we know little about them. 350 species have been described so far in Switzerland. Most of them were discovered by chance, such as the *Myzodium modestum* aphid, which lives in and feeds on moss. This species occurs in Switzerland’s neighboring countries, as well as in Scandinavia, Russia, Greenland and North America, but until now no specimen has been found in Switzerland – because no one looked! WSL researchers came across it by chance in the Swiss National Park in summer 2013 when they were checking food webs in pastures.

What made the find so special is that it consisted of two winged males and a female. Such sexual forms have never been identified in aphids living exclusively on moss before. Scientists assumed that these

aphid species were propagated through parthenogenesis, a form of asexual reproduction in which the young develop from unfertilized eggs. Finding these sexual forms in the Swiss National Park has now disproved this assumption – a small step for science, but great satisfaction for the discoverer. (lbo)



Prepared female aphid specimen of *Myzodium modestum*.

Mountain hares – losers out to climate change?



The future of mountain hares in the Swiss Alps is uncertain.

Mountain hares have fascinated Maik Rehnus for a long time – last year he duly celebrated ten years of research. His justification for his great interest in the animal is that “mountain hares are the indicator species for Arctic-Alpine ecosystems because,” he says, “they react very sensitively to environmental changes.” Their behavior serves as an early-warning system.

Maik spends about sixty days a year tracking the shy survival artists in the Swiss Alps, or more precisely, their faeces. He and his Austrian colleagues have developed a new method to study mountain hares without disturbing them. The researchers use fresh ‘pellets’ to test for stress. “With this method we don’t have to catch the stress-sensitive animals,” explains Maik, a Saxon from birth. Stressed animals require up to 20%

more energy than undisturbed ones, as he was able to show in a study in the Natur- und Tierpark Goldau. He also found that the concentrations of stress hormones in the faeces of wild mountain hares living in winter-sport areas were higher than in those of hares living in undisturbed areas in the Swiss National Park, which is closed in winter.

He also investigated how the distribution of mountain hares is changing with climate change. Maik’s conclusion: If the climate warms as predicted, the habitat of the mountain hare, which is adapted to the cold, will shrink and become fragmented.

If habitats are isolated, inbreeding may occur, which raises the risk of extinction. This would have an impact on endangered species like the eagle owl and the golden eagle, which regularly have mountain hares on the menu.

“Ten years ago we knew very little about mountain hares in the Alps,” says Maik. Today the results can be used for making practical recommendations. The wildlife ecologist is working with colleagues at WSL on developing methods for monitoring mountain hares throughout Switzerland to provide advice on hunting the mountain hare sustainably. (ssc)

Nora Helbig, Davos

“I feel at home on Schatzalp. I live close by and often run here as it helps me unwind. The quiet, the colorful landscape and abundant wildlife up here make it a special place for me.”



IN THE INTERESTS OF FLOOD PREDICTION

When the snow melts, the meteorologist Nora Helbig is particularly in demand. She analyses how much snow is expected to melt in different areas in Switzerland for the Operational Snow-Hydrological Service (OSHD) at SLF. Her calcu-

lations are fed into the flood predictions of the Federal Office for the Environment FOEN. She spends the rest of the time improving the physical description of snow-melt processes in the OSHD models.

Radar reveals the inside of a powder avalanche



Researchers in the observation bunker use GEODAR, a radar system, to analyze the flow behavior of avalanches.

Several muffled detonations shake the Vallée de la Sionne above Arbaz, a village in Canton Valais, on 3 February 2015. The snow slab at 2700 meters altitude starts to slide. Within seconds an avalanche forms, its core soon disappearing in a powder cloud of suspended snow. SLF researchers released the avalanche artificially in the cordoned-off test area.

What happens under the powder cloud?

To calculate how far avalanches flow and what dynamic processes play a role, researchers need to be able to understand the flow behavior of avalanches as precisely as possible. While the test avalanche is nearing the valley floor, Anselm Köhler and Martin Hiller from SLF are sitting with Jim McElwaine from Durham University in the observation bunker underneath the avalanche slope. Their gaze moves back and forth between the reinforced tank-glass bulls-eye window, which allows a distorted view of the avalanche slope, and their computer screens. There they can see the data measurements of the

radar antennas mounted on the outer wall of the bunker. The radar system enables them to see through the dust cloud and watch how the denser flowing part of the avalanche moves.

Understanding the dynamics of avalanches better

Anselm, who is analyzing the radar measurements as part of his doctorate, explains, “We have been able to verify directly, for the first time, what avalanche researchers have long suspected: large avalanches consist of many individual so-called ‘surges’, whose velocities we can measure.” Secondly released avalanches may develop into large surges, which move inside the original avalanche and develop their own dynamics. Smaller surges of denser snow may also form, some of which flow faster than the main mass of the avalanche. They may break through the front of the avalanche proper, where they will be slowed down quickly. The researchers attribute the different flow velocities in the avalanche to differences in friction. These new insights should help to develop physical models of avalanches further by taking their complex flow behavior better into account. *(mbe)*

www.slf.ch/more/radar-en

NATURAL HAZARDS Hanging glacier under observation: SLF expertise is helping to protect the Jungfrau railway

The Jungfrau train stops at the Eigergletscher station. The awed tourists take photos of the mountain panorama. Then the train goes into the seven-kilometer long tunnel up to the Jungfraujoch. What very few of the passengers know is that, to ensure their safety, the most up-to-date technology is being used to monitor the glacier above the station day and night.

It is normal for glaciers to move. The condition of the hanging glacier on the west flank of the Eiger, however, started to become critical in autumn 2015. Glaciologists from ETH noticed that a crevasse was forming behind the front of the glacier, which was separating off an ice lamella as large as about 80 houses with a volume of 80'000 m³. Should the lamella break off, the railway station could be threatened. The Jungfrau railway, which takes about a million passengers a year to the 3453 m a.s.l. summit, reacted immediately and commissioned the SLF to provide an expert assessment of the hazard situation. Stefan Margreth, Head of the Group

‘Avalanche Protection Measures’, simulated four different scenarios with the computer software RAMMS and determined which measures should be taken. An ice fall is particularly critical if there is a lot of unstable snow below the glacier that could be swept into an ice avalanche. On Stefan’s advice, a radar system has been continuously monitoring the glacier movements since March 2016. Any break-offs can now be detected several days in advance, and the areas at risk closed as a precaution. In winter, an avalanche radar is used in addition. If it records a break-off, the trains can then be stopped in time.

(sni)

Westflank of the Eiger with hanging glacier (▲) and Eigergletscher-Station (■).



NATURAL HAZARDS All good things come from above: Drones open up new opportunities for snow research



Yves Bühler 'flies' with his drones over avalanche deposits.

Drones buzz over our heads increasingly often and also keep the media buzzing – whether it has to do with protecting personal privacy or a drone crash that narrowly misses hitting a ski-racer, as actually happened during a World Cup slalom in Madonna di Campiglio (I) in 2015.

SLF researchers also rely on drones – not to film people, but to

study snow. Yves Bühler, a remote-sensing specialist at SLF says, “The advantages of using drones are obvious. Drones are cheap and take high-resolution pictures. They can be used quickly and flexibly in regions that are inaccessible or difficult to get to.”

Measuring avalanches safely

Yves invests a lot of time into making sure that his drones fly without a hitch. Before deploying them, he uses maps and terrain models to program on the computer where he later wants his drone to fly. In the field he then adapts the flight plan to the prevailing terrain, wind and temperature conditions before the drone automatically searches for the predefined route using the built-in GPS. On 7 February 2015, for example, he and his co-pilot Andreas Stoffel ‘flew over’ the release zone and snow deposits of the Wildi avalanche, which had come down in the Dischma Valley in Davos three days earlier. The researchers then created a digital surface model from the camera images using photogrammetric software. About three months later, they flew over the same area again, which was by then free of snow. By comparing the two surface models, Yves could calculate the release depths of the Wildi Avalanche’s snow deposits with an accuracy close to 20 cm. Yves explains, “This method enables us to document the course of an avalanche accurately and efficiently without us having to set foot in dangerous terrain.” If detailed surface models of the snow-free area prior to the avalanche are available,

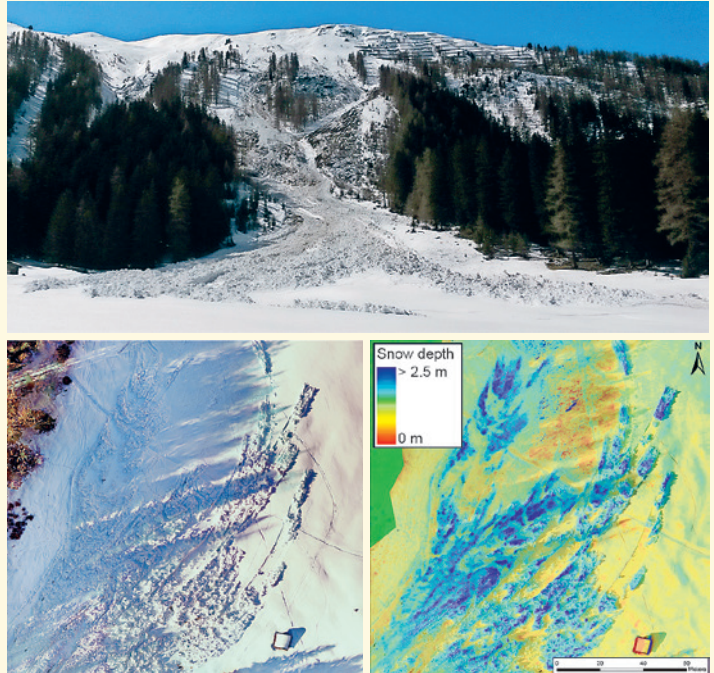
the dimensions of the avalanche deposits can be determined directly after the event.

Technology of the future

Surface models calculated using information from drone flights can also improve computer simulations of natural Alpine hazards, such as rock-fall, debris flows and avalanches. The more precise the model of the terrain is – and precision is a basic prerequisite for such simulations – the more exactly natural hazards can be simulated on the screen using the simulations-software RAMMS. The simulation provides indications about how seriously threatened residential areas and transport routes are, and how they can best be protected. Another interesting use of drones is determining the snow depth across a complete area. If you want to know how much snow there is somewhere, and how the snow depth has changed during the winter, you used to have to rely primarily on data from the automatic weather stations. Snow depths for the areas between the stations then had to be interpolated using mathematical functions – with corresponding inaccuracies since the snow cover sometimes varies considerably over very small areas. Yves managed to determine snow depths very accurately in very different terrains based on several surface models obtained from drone flights under snow-free and snow-covered conditions. His estimates have been confirmed by manual measurements in the field.

Snow monitoring from the air opens up new opportunities for snow research. Not only can avalanche warning benefit from such data, but better forecasts can be made of how much water is stored in the snow at

particular sites, and thus how much may be released when the snow melts. This is important information for the hydro-electric power industry and for flood warning. It may also help optimize the preparation of ski-runs or decide where automatic avalanche release systems should be placed. In the



Top: Wildi avalanche near Davos, GR. Bottom left: Aerial photo of the deposit of the Wildi avalanche. Bottom right: Estimated depths of the Wildi avalanche's deposit based on the surface models from the drone flights.

meantime Yves has received requests from people interested in the measurement technology for practical purposes. Canton Grisons, for example, gave him the task of flying over an area in the Engadine to find out how windbreaks influence the deposition of transported snow. (chu)

www.slf.ch/more/drones-en

www.slf.ch/more/remote_sensing

SNOW AND ICE A games console helps to make studies of snow drifting more precise



In the SLF's wind tunnel, researchers can study the transport of snow.

Wind can transport large quantities of snow and thus greatly influence the distribution of snow in alpine and polar regions. In areas where drifting snow accumulates, avalanches can form. SLF researchers in Davos are therefore using a 14-meter-long wind tunnel to investigate how wind moves snow. They want, for example, to understand better the way the transport of snow varies according to the strength of the wind and the characteristics of the snow cover. This is why they create wind under controlled conditions with speeds of up to 70 kilometers per hour and realistic turbulence immediately above a natural snow cover.

The doctoral student, Philip Crivelli, is studying the shapes ero-

sion takes when it is formed by wind on a snow surface. For this he uses an instrument that was originally developed as a movement sensor for a computer-game console. With the infrared sensor, the exact positions of objects in space can be determined. Philip uses this capability to measure the snow surface in the wind tunnel three-dimensionally at a high resolution, and then follows how it changes over time. The researchers also use other measurement methods, such as a snow-particle counter and 'shadowgraphy'. The latter involves illuminating snow particles from one side of the wind tunnel and filming them from the other side with a high-speed camera. From the resulting sequence of shadow images, the re-

searchers can then determine the speed, size and spatial distribution of the transported snow particles.

Snow transport is a complex phenomenon

With this experimental procedure, Philip and his colleagues have been able, for the first time, to follow in detail how wind erodes and deposits snow particles. Turbulence close to the ground is one important factor. Another factor is the state of the snow cover because impacting particles can knock other particles loose from the snow cover. Since the individual snow particles are bonded together with fine bridges of ice, a certain force is required to break these bonds before the wind can transport

the individual particles away. Finally, the changing snow surface also influences the transport of snow. The measurements in the wind tunnel will enable researchers to better describe the complex transport of snow in weather and climate models in future. *(mbe)*

www.slf.ch/more/wind_tunnel

SNOW AND ICE The art of storing snow over summer

Winter-sport regions have, during the past few years, increasingly relied on snow farming to store snow over the summer. This involves piling up massive heaps of snow several meters high towards the end of winter at suitable outdoor sites and covering them with an insulating layer of, e.g., sawdust. This layer protects the snow beneath it and prevents it from melting. The conserved snow can then be used as a basis in preparing cross-country ski trails, ski slopes or ski jumps at the beginning of the following winter. Researchers at SLF used laser scanning to produce high-resolution images at two snow-farming sites and found that about three-quarters of the snow can be kept over the summer. They have also adapted the computer model SNOWPACK so that it can predict how much snow will be lost. The researchers are now using the model to



Snow stored over the summer can be used to prepare cross-country trails or ski slopes at the beginning of winter independently of the weather.

select, among other things, suitable sites for snow farming. *(mbe)*

Matthias Bürgi,
Birmensdorf

“I spend one day a week working in our vineyard Rütihof in Uerikon, which my wife and I run together. Working in the vineyard is a really pleasant counterbalance to everyday office life. I enjoy looking after the hay meadows, hedges and dry stone walls on our land.”



IDENTIFYING CHANGES IN THE LANDSCAPE

Matthias Bürgi is an environmental scientist in charge of the Research Unit 'Landscape Dynamics'. The researchers in this Unit study the growth of trees, how some species spread and how the landscape is changing. They also take

climate change into account. In his own projects, Matthias' main focus is on the history of landscapes. "Looking back helps us to understand the future better."



A landscape is an important basis for life and the economy. Landscapes are, however, always changing. Where once cows grazed, today there are apartment and office blocks, and on former raised bogs vegetables are growing. The pressure on natural landscapes is enormous, especially in densely populated regions. WSL researchers are studying why and how landscapes change, and what this means for people and the environment.

DIAGONAL can be ordered free of charge: www.wsl.ch/diagonal

Request individual copies:
Swiss Federal Research Institute WSL
Zürcherstrasse 111,
CH-8903 Birmensdorf
eshop@wsl.ch; www.wsl.ch/eshop

IMPRINT

Publisher:
Prof. Dr. Konrad Steffen, WSL Director

Text:
Lisa Bose (lbo), Martin Heggli (mhe),
Christine Huovinen (chu), Beate Kittl
(bki), Reinhard Lässig (rlä), Sara
Niedermann (sni), Birgit Ottmer (bio),
Stephanie Schnydrig (ssc)

Editorial management:
Lisa Bose, Christine Huovinen;
diagonal@wsl.ch

Translation: Silvia Dingwall, Nussbaumen

Design: Raffinerie AG für Gestaltung,
Zurich
Layout: Sandra Gurzeler, WSL

Printing: Sihldruck AG, Zurich

Circulation and frequency of
publication: 400, twice annually

The WSL magazine DIAGONAL is also
published in German and French.

Cite as:
Swiss Federal Research Institute WSL,
2016: WSL magazine Diagonal, 1 / 17.
36 pp., ISSN 2296-3561

PEOPLE



The WSL editorial team, from left to right, top row: Birgit Ottmer, Sandra Gurzeler, Reinhard Lässig, Beate Kittl; bottom row: Christine Huovinen, Lisa Bose, Martin Heggli

SNOWMICROPEN

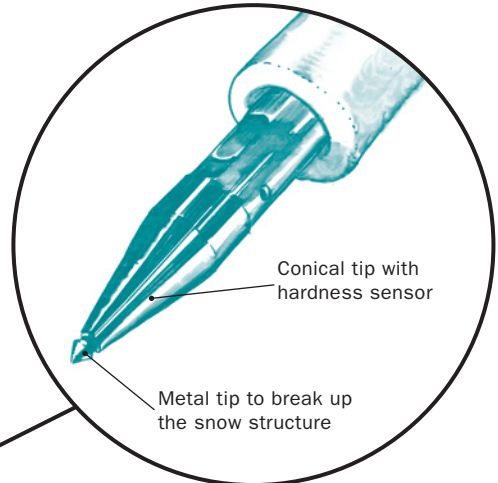
Measurement signal amplifier



Metallic rod

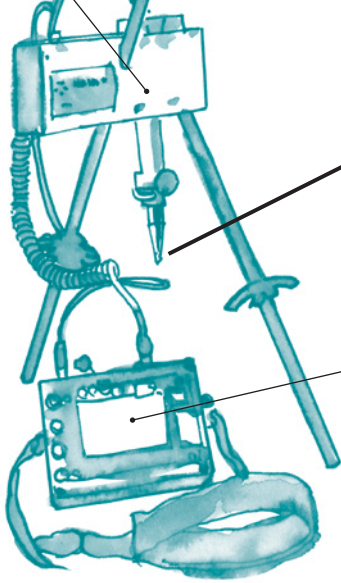
Motor to drive the measurement tip into the snow cover

Ski-pole to hold the instrument in place

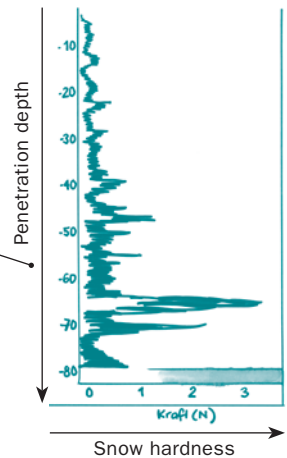


Conical tip with hardness sensor

Metal tip to break up the snow structure



Battery-powered controller unit with display



The SnowMicroPen (Snow Micropenetrometer) was developed at SLF to measure snow-cover hardness without having to shovel snow. Such measurements allow conclusions to be drawn about the snow density and structure, and thus about the snow stratigraphy, which is an important factor in avalanche formation.

Video at: www.wsl.ch/object



LOCATIONS

Birmensdorf

Eidg. Forschungsanstalt
für Wald, Schnee und
Landschaft WSL
Zürcherstrasse 111
CH-8903 Birmensdorf
Phone 044 739 21 11
Fax 044 739 22 15
wslinfo@wsl.ch
www.wsl.ch

Lausanne

Institut fédéral de
recherches WSL
Case postale 96
CH-1015 Lausanne
Phone 021 693 39 05
Fax 021 693 39 13
antennenromande@wsl.ch
www.wsl.ch/lausanne

Sion

Institut fédéral de recherches
WSL
c/o HES-SO
Route du Rawyl 47
CH-1950 Sion
Phone 027 606 87 80
valais@wsl.ch
www.wsl.ch/sion

Davos

WSL-Institut für Schnee-
und Lawinenforschung SLF
Flüelastrasse 11
CH-7260 Davos Dorf
Phone 081 417 01 11
Fax 081 417 01 10
contact@slf.ch
www.slf.ch

Cadenazzo

Istituto federale di
ricerca WSL
a Ramél 18
CH-6593 Cadenazzo
Telefon 091 821 52 30
info.cadenazzo@wsl.ch
www.wsl.ch/cadenazzo

RESEARCH FOR PEOPLE AND THE ENVIRONMENT

The Swiss Federal Institute for Forest, Snow and Landscape Research WSL conducts research into changes in the terrestrial environment as well as the use and protection of natural spaces and cultural landscapes. It monitors the condition and development of the forests, landscapes, biodiversity, natural hazards, and snow and ice, and develops sustainable solutions for problems that are relevant to society – together with its partners from science and society. WSL plays a leading international role in these research areas, providing the basis for sustainable environmental policy in Switzerland. WSL employs more than 500 people in Birmensdorf, Cadenazzo, Lausanne, Sion and Davos (WSL Institute for Snow and Avalanche Research SLF). It is a Swiss federal research center and part of the ETH Domain. You can find WSL's annual report online at: www.wsl.ch/more/annualreport.



Drones: New perspectives for snow research, p. 30



The mountain hare: Loser out to climate change? p. 26

